Journal of Experimental Psychology:
Learning, Memory, and Cognition
2001, Vol. 27, No. 4, 941–947

0278-7393/01/$5.00 DOI: 10.1037//0278-7393.27.4.941

On the Dual Effects of Repetition on False Recognition

Aaron S. Benjamin
University of Toronto and the Rotman Research Institute at Baycrest Centre for Geriatric Care

The effects of study-list repetition on false recognition of semantic associates were examined using aging (Experiment 1) and recognition time pressure (Experiment 2). Participants studied word lists, each of which was composed of high associates to a single, unstudied word (the *critical lure*). Under normal testing circumstances, young adult participants (ages 19–26) falsely endorsed fewer critical lures associated with lists that had been presented multiple times than lists presented only once. However, young participants tested under time pressure and older participants (ages 67–85) endorsed a greater number of critical items associated with lists presented thrice than with lists presented once. The results suggest dual bases for the recognition decision, one of which is based on the rapid spread of activation within domains of semantic similarity and the other of which functions to attribute that activation to likely sources and set appropriate decision criteria. The latter capacity is compromised both under conditions of time pressure and in the elderly.

Various phenomena collectively referred to as *false memory* or *illusions of memory* have piqued much interest in several research communities, including memory theorists (Deese, 1959; Loftus, 1979; Payne, Neuschatz, Lampinen, & Lynn, 1997; Roediger & McDermott, 1995), neuroscientists (Balota et al., 1999; Johnson, 1991; Schacter, Verfaellie, & Pradere, 1996), scholars of memory and aging (Kensinger & Schacter, 1999), metamemory theorists (Benjamin, Bjork, & Schwartz, 1998; Metcalfe & Wiebe, 1987), psychologists concerned with courtroom testimony and legal issues (Ceci & Bruck, 1995; Loftus, 1993), and hypnosis researchers (Lynn, Lock, Myers, & Payne, 1997; Lynn & Nash, 1994). The recent widespread appeal adequately reflects the profound implications of understanding why we often fail to remember events accurately, and occasionally even remember events that never occurred at all (cf. Loftus, 1997; Roediger & McDermott, 1995).

As argued eloquently by Roediger (1996), studying illusions of memory has the potential to inform our theories of memory in the same manner that the study of perceptual illusions has aided in the development of models of perception. Controlled studies of memory illusions also address an applied interest in understanding the nature of eyewitness memory and recovered memories. There have been a number of highly publicized courtroom cases in which testimony based on potentially false memories have served as pivotal evidence (see, e.g., Pezdek & Banks, 1996), and a more adequate conception of the reconstructive nature of memory may provide an informed basis for the resolution of certain difficult legal issues.

Aaron S. Benjamin, Department of Psychology, University of Toronto, Toronto, Ontario, Canada, and the Rotman Research Institute at Baycrest Centre for Geriatric Care, Toronto, Ontario, Canada.

I thank Sharyn Kreuger for her assistance in administering the experiments discussed here and Gus Craik, Kathleen McDermott, and Chuck Weaver for their helpful comments on the data and the article.

Correspondence concerning this article should be addressed to Aaron S. Benjamin, who is now at the Department of Psychology, University of Illinois, 603 East Daniel Street, Champaign, Illinois 61820. Electronic mail may be sent to asbenjam@s.psych.uiuc.edu.

This article examines the effects of study-list repetition on false recognition and makes use of the paradigm introduced by Deese (1959) and resurrected by Roediger and McDermott (1995). In that paradigm, participants typically study lists of words that are high semantic associates of an additional unstudied word. I concentrate here specifically on the finding that, on a test of recognition, participants falsely endorse that unstudied semantic associate (henceforth, the *critical lure*) at very high rates, sometimes as high as the hit rates for the studied items themselves (Payne, Elie, Blackwell, & Neuschatz, 1996). This false recognition effect is quite powerful: Participants recognize these unstudied items with high confidence and are quite willing to claim that they actually recollect their presentation (Roediger & McDermott, 1995), and even are willing to report which of a set of voices spoke the item during study (Payne et al., 1996).

The experiments presented here address the etiology of false memory by evaluating the effects of study-list repetition on false recognition. On the one hand, certain researchers have proposed encoding-based effects as the locus of the false recall and recognition of semantically related stimuli (e.g., Marsh & Bower, 1999). The crux of such hypotheses is that the critical lure is generated by the participant during the study phase and then misremembered as having been presented, rather than imagined. By that view, repeating the study list should increase the opportunity for the imaginal generation of the critical lure and should thus increase the probability of false recognition to that item.

On the other hand, a wealth of data illustrate the *mirror effect* (e.g., Glanzer, Adams, Iverson, & Kim, 1993). The mirror effect refers to the regularity of the finding that the recognition of more memorable or more well-learned material is accompanied by lower rates of false recognition to distractor stimuli than during recognition of less well-known material. If the false recognition of semantically related material (e.g., Roediger & McDermott, 1995) is no different than any other type of false recognition, then repetition of the study list should increase knowledge of the study set and consequently decrease the probability of false recognition.

The data presented here illustrate how both effects obtain, but under different circumstances. I thus argue that the effects of study-list repetition on false recognition are twofold. First, by virtue of a mechanism that enables spreading activation within semantic domains (and perhaps other domains as well; cf. Sommers & Lewis, 1999), repetition makes the critical lure more familiar and thus fosters higher rates of false recognition for that item. However, increasing knowledge of the true members of the study set enables the recognizer to increase the criterion for using familiarity as a basis for the recognition decision, and thus leads to a lower rate of false recognition. The implications of these dual effects of repetition for formal models of recognition are discussed in the final portion of this article.

In the first experiment reported here, these dissociative effects of repetition are revealed as a function of age. These results supplement the recent findings of Balota et al. (1999), Jacoby (1999), and Kensinger and Schacter (1999), which are discussed below. In the second experiment, the dual effects of repetition on false recognition are evident on an entirely within-subjects basis by manipulating the time pressure under which participants are forced to make a recognition decision. The similar effects of these two variables—aging and response speeding—have been noted elsewhere (e.g., Benjamin & Craik, in press) and provide for an examination of the complex effects of study-list repetition on false recognition.

Experiment 1: Aging and Repetition

Experiment 1 addresses the differential effects of repetition on young and elderly participants. Because others have argued (e.g., Benjamin & Craik, in press; Jacoby, Toth, & Yonelinas, 1993) that familiarity effects are relatively automatic and are maintained throughout the course of nonpathological aging (cf. Benjamin, Kester, Craik, & Black, in press; Mitchell, Hunt, & Schmitt, 1986), but that the consciously controlled processes that link memory to a specific time and place in the past are compromised in elderly adults, it was hypothesized that the effects of repetition would differ between young and elderly participants. Specifically, young participants should be able to correctly "counter" the familiarity-enhancing effects of repetition with an increase in recollection for the truly studied items, thus leading to a stricter criterion for translating familiarity into a positive judgment of recognition. However, because older participants lack this recollective ability (e.g., Cohen & Faulkner, 1989), they should not have the ability to reject the increasingly familiar critical lures. Consistent with this interpretation is the finding that, whereas the accuracy of veridical memory decreases with age, susceptibility to false memory increases (Balota et al., 1999).

In Experiment 1, however, the critical prediction is of an interaction between age and repetition on rates of false recognition for the critical lures. Specifically, false recognition is expected to decrease with study-list repetition for young participants, but increase with repetition for older participants. A similar interaction has been reported by Jacoby (1999), who has shown that the study repetition of items that are to be rejected can have the "ironic" effect of increasing false alarms in older participants and in time-pressured young participants. Similarly, Kensinger and Schacter (1999) reported that false recall declined for young but not for older participants over successive study–test trials. Because of the questionable role that multiple testing opportunities play in fostering future false recall, repetition is manipulated on a between-items basis in the experiments reported here.

Method

Participants. The young participants were 16 undergraduate students (12 women and 4 men) at the University of Toronto, who ranged in age from 19 to 26 years (M = 22.4 years). Mean performance on the Mill Hill vocabulary test was 53%. All of the young participants participated in order to gain extra course credit in an introductory course in psychology. There were 15 elderly participants (8 women and 7 men) recruited from the greater Toronto area, ranging in age from 67 to 85 (M = 74.3 years). Mean performance on the Mill Hill test was 75% for older participants, which was reliably higher than the scores for young participants, $t(29) = 4.48$. The young participants had a mean of 16.2 years of education, and the older participants had a mean of 16.8 years of education.

Design. The study used a 2 (age group) × 3 (word type) × 2 (repetition category) factorial design. On the test, participants viewed old (studied), critical (unstudied but highly associated), and distractor (unstudied and distantly associated) items from categories that had been studied once and categories that had been studied three times. Both the word and repetition variables were manipulated on a within-subjects basis. The probability of a positive recognition response to each of these categories was measured.

Materials. Ten 11-word lists were taken from the Appendix section of Roediger and McDermott (1995). The top 8 ranked associates of a given critical item were used as the study list for a given category, and associates 9 through 11 were used as category-related distractors. The test consisted of 80 items, 40 of which were taken from the study lists (old items) and 40 of which were new (critical foils and categorical distractors). Of the 40 old items, 4 were randomly chosen from each of the 10 lists. Thus, the make-up of the test lists for individual participants differed only in which particular studied items were re-presented. Of the new items, 30 were categorical distractors (3 from each list) and the remaining 10 were the critical lures, 1 from each list. The order of test items was random, subject to the constraint that each block of 8 items contained 1 critical item, 3 categorical distractors, and 4 studied items (2 from each of the repetition conditions). All presentation of words and recording of responses was done on PC microcomputers programmed in QBASIC.

Procedure. Participants were tested individually and in pairs. After instructions to learn all of the items as well as possible, each participant viewed all 10 lists. Each list was preceded by a 5-s cue informing the participants that a new list was to be presented and how many times it would be viewed. All of the items remained on the screen for 3 s, with a 1-s interval between words. One half of the lists were presented three times in immediate succession, with no break between the list presentations. For one half of the participants, the thrice-repeated lists were the even ones; for the other half of the participants, the thrice-presented lists were the odd ones.

After the participants viewed all 10 lists, a short distractor period ensued in which they solved arithmetic problems. This period lasted 5 min and was followed by instructions for the recognition test. Participants were told to evaluate each word on the test and decide if it had been presented during the study episode. They were to press the "Y" key if they believed the item to have been studied and to press the "N" key otherwise. All of the items remained on the screen until the participant made a response, and there was no time limit.

Results

Unless otherwise noted, all of the results reported here and throughout this article are reliable at the α = .05 level, using two-tailed tests. Rates of positive recognition responses are shown in Figure 1. For old items, endorsement rates increased with repetition for both young, $t(15) = 2.75$, and older, $t(14) = 3.87$, participants. It is thus evident that repetition had the desired effect of increasing memory for the study-list items.

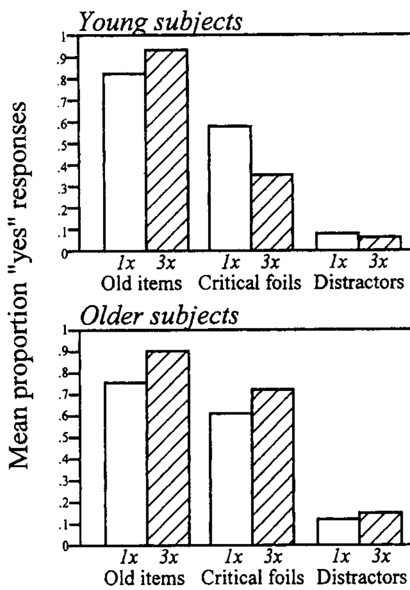

Figure 1. Mean proportion "yes" responses as a function of repetition and test item type for young (top) and older (bottom) participants.

More important, it can be seen that repetition had different effects in older and younger participants on the false recognition of the critical lures, simple two-way interaction, $F(1, 30) = 11.34$. Rates decreased for young participants, $t(15) = 3.20$, but increased for elderly participants, $t(14) = 1.60$, $p = .06$. For the distant distractors, there were no differences in false-alarm rates between repetition conditions for either young or older participants, but the older participants did have a higher rate of false alarms overall, $t(29) = 2.41$.

Discussion

In Experiment 1, it has been shown that repetition has two effects on false recognition. For young participants, increasing the number of times that a study list was viewed decreased false recognition of semantic associates to that list. However, false recognition increased with study-list repetition for older participants. This between-groups dissociation is consistent with the interpretation that (a) repetition has the dual effects of enhancing the familiarity of the unstudied critical lures and providing for increasingly strict criteria in recognition and (b) that elderly participants lack the ability to make use of the latter capacity. This interpretation suggests that the apparently equal ability of old and young participants in the recognition of truly studied items owes partly to a more liberal criterion for recognition used by the elderly group. The finding of higher false-alarm rates to distant distractors by older participants supports this interpretation.

Signal-detection-analysis parameters for the discrimination of studied items from critical foils are shown in Table 1. [1] The results of this analysis confirm several of the speculations made above. First, the recognition criterion (C_j) increases with repetition (and the consequent greater knowledge of the study list) for young participants, $t(15) = 3.30$.[2] This shift parallels an increase in recognition discriminability (d'), $t(15) = 5.01$ (cf. Hirshman, 1995). Older participants show no such increase in discriminability, $t(15) = 0.40$, *ns*, and the criterion shifts downward, $t(15) = 2.18$. Age and repetition had reliable interactive effects on d', $F(1, 29) = 11.60$, and β, $F(1, 29) = 17.25$. These results confirm the earlier supposition that older adults enjoy the automatic familiarity-enhancing effects of repetition (as shown by the increase in false-alarms rates with repetition to critical foils) but lack the additional memorial capacity that affords the upward movement of the recognition criterion.

The goal of Experiment 2 was to replicate on a within-subjects basis the dissociation evident between age groups in Experiment 1. Administering time pressure at the time of the decision has been noted to have similar effects as does aging on recognition performance (Benjamin & Craik, in press). Presumably, this parallel arises because time pressure compromises the input of consciously controlled recollective processes to the decision and thus shifts the potential bases for the decision to more automatic familiarity-based sources (Benjamin & Bjork, 2000; Hintzman & Curran, 1994).

Experiment 2: Time Pressure and Repetition

In Experiment 2, I attempted to replicate the dissociation evident in Experiment 1 by using time pressure at the time of the recognition decision. Time pressure was manipulated within subjects and was implemented by instructions and feedback. The participants were told that, while tested under speeded conditions, they would need to respond within three fourths of 1 s. In addition, on each trial that their response latency exceeded 750 msec, they were reminded to make their responses more quickly in the future. However, all responses—including those that exceeded the deadline—were tabulated in the results. This inclusiveness avoids tricky (and insurmountable) problems with item-selection effects.

The critical prediction is of an interaction between time pressure and repetition on the false recognition of critical lures. Under unpressured conditions, the effect evident with young participants in Experiment 1 should replicate: False alarms to critical lures should decrease with repetition. However, under time-pressured conditions, false alarms to those items should increase with repetition.

Method

Participants. A total of 30 young participants (25 women and five men) participated in the experiment. Their mean age was 19.8 years and

[1] The use of signal-detection theory here is compromised somewhat by the fact that the critical lures are drawn from a potentially different population of items than are the studied items. These results are used to illustrate effects already evident in the data, rather than to aid in the evaluation of signal-detection theories of false memory (cf. Miller & Wolford, 1999; Wickens & Hirshman, 2000; Wixted & Stretch, 2000).

[2] The parameter C_j is estimated solely on the proportion of positive responses to the critical items. This characteristic differentiates it from other estimates of bias, such as C or β, which take into account the distance between the distributions. In this situation, β (and log β) are not preferable measures because of the differential memorability of the singly versus multiply presented items (cf. Lockhart & Murdock, 1970), as well as the potential dependence of β on d' (Snodgrass & Corwin, 1988). In addition, because our concern here is with the direction of criterion movement relative to the highly familiar critical lures—rather than evaluating the strictness of the criterion relative to an unbiased decision maker—there is no reason to prefer C over C_j. In fact, the two values covary in almost every instance.

Table 1
Signal Detection Parameters for the Discrimination of Studied Items From Critical Foils

Repetition	Parameter d'	Parameter C_j
Experiment 1		
Young participants		
Once-presented	0.91	−.27
Thrice-presented	2.21	.59
Older participants		
Once-presented	0.46	−.32
Thrice-presented	0.57	−.86
Experiment 2		
Unspeeded test		
Once-presented	0.48	−.08
Thrice-presented	1.66	.28
Speeded test		
Once-presented	0.14	.18
Thrice-presented	0.11	−.38

mean performance on the Mill Hill test was 48%. All were undergraduates at the University of Toronto and participated for course credit.

Design. The experiment used a 2 (time pressure) × 3 (word type) × 2 (repetition condition) completely factorial within-subjects design.

Materials. The materials were expanded from Experiment 1 in order to accommodate the additional variable while maintaining similarly variable measures. Participants each studied 16 lists drawn from Roediger and McDermott (1995), one half of which were presented three times and the other half once. Each test (speeded and unspeeded) contained 72 items, of which 32 were previously studied, 32 were distant distractors, and 8 were critical lures. Each block of 9 items contained 1 critical lure and 4 of each of the other item types. Of the 32 old and 32 distractor items on each test, 2 were drawn from each of the 16 studied lists. Of the 8 critical lures, 4 came from each repetition condition.

Procedure. The study and distraction phases proceeded as in Experiment 1. One half of the participants were first tested under speeded conditions, and the other half were first tested under unspeeded conditions. Instructions prior to the first test informed them of their task, as in Experiment 1; they were also informed as to the nature of the deadline procedure during the speeded test. During the speeded test, they were reminded to make their responses more quickly each time their response latency exceeded 750 msec. Otherwise, the procedure was the same as in Experiment 1.

Results

The results from Experiment 2 are presented in Figure 2. Old items studied three times elicited more positive recognition responses than did old items studied once under both unspeeded, $t(29) = 7.94$, and speeded, $t(29) = 5.60$, conditions. As in Experiment 1, there were no differences between false-alarm rates for far distractors as a function of repetition, but the rate was higher on the speeded than on the unspeeded test, $t(29) = 5.24$.

There was a simple interaction between repetition and time pressure at test for the critical lures, $F(1, 29) = 11.14$. False recognition increased with number of study exposures, $t(29) = 3.00$, under speeded conditions but decreased, $t(29) = 1.69$, $p < .05$, one-tailed, under unspeeded testing conditions.

Discussion

The results of Experiment 2 mirror those found in Experiment 1. Study-list repetition increases recognition accuracy for studied items under both speeded and unspeeded conditions, but only increases the accuracy with which participants can reject highly plausible foils when there is no time pressure imposed at test. When the recognition decision is speeded, false alarms to the critical foils increase—and, consequently, accuracy decreases—with study-list repetition. The results of Experiment 2 reveal this dissociation on a within-subjects basis that cannot be attributed to group-based strategic differences in recognition between young and the elderly participants.

Signal-detection parameters (shown in Table 1) reveal that the effects of time pressure during recognition are similar to those evident in the older participants. There is an interaction between time pressure and repetition on criterion placement, $F(1, 29) = 10.57$, so that criteria shift upward with repetition under unspeeded conditions, $t(29) = 1.99$, $p = .06$, but become more lenient with repetition under speeded conditions, $t(29) = 3.29$. There is also an interaction, $F(1, 29) = 18.93$, between repetition and time pressure on d', so that discrimination increases significantly with repetition under unspeeded, $t(29) = 4.70$, but not speeded, $t(29) = 0.11$, *ns*, conditions.

General Discussion

The experiments reported here reveal two effects of repetition on the false recognition. Young participants tested under unspeeded conditions benefit doubly from study-list repetition: True recognition (hits to studied items) increases, and false recognition (false alarms to critical foils) decreases. However, when young participants are tested under speeded conditions, or when elderly participants are tested, the pattern changes. True recognition still improves with repetition, but false recognition increases as well.

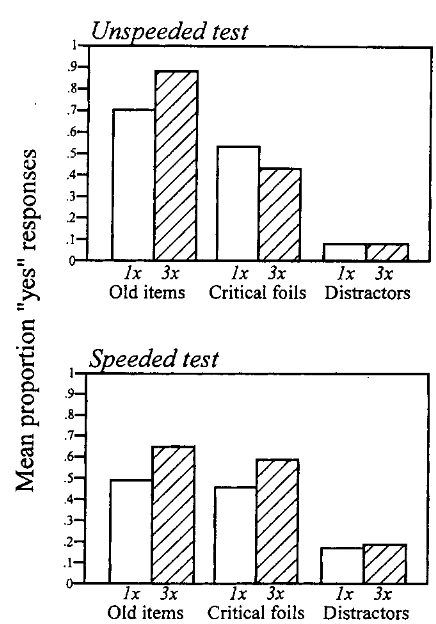

Figure 2. Mean proportion "yes" responses as a function of repetition and test item type on unspeeded (top) and speeded (bottom) recognition tests.

Similar dissociative patterns are also evident in the effects of repetition (Jacoby, 1999) and spacing (Benjamin & Craik, in press) on list-membership judgment.

These results provide strong evidence for multiple contributions to the recognition decision. The first process, which serves to spread activation within semantic neighborhoods, underlies the sense of familiarity that both old items and highly plausible new items, such as the critical foils, evoke at test. We assume that this process executes rapidly because the effects of semantic relatedness on false recognition are evident in time-pressured recognition. The second process functions to search for an appropriate source for that phenomenological sense of familiarity, evaluate the diagnosticity of familiarity as a basis for recognition, and set appropriate decision criteria. This latter function takes some time to execute and appears to be compromised in the elderly participants.

Such dual-process views of recognition have a long history in memory research (e.g., Atkinson & Juola, 1974; Mandler, 1980) and have traditionally competed against *global strength* theories that seek to explain recognition phenomena using only a single process (for a review of such models, see Clark & Gronlund, 1996). In fact, one global strength model, the Minerva2 of Hintzman (1986, 1988), has been applied to false-memory phenomena (Arndt & Hirshman, 1998). They showed that, by augmenting the model with a recognition decision criterion that varies with degree of learning (cf. Hirshman, 1995), Minerva2 can handle the phenomenon that true recognition increases whereas false recognition decreases with additional learning. This simulation of the mirror effect (Glanzer et al., 1993) replicates the effects of repetition shown by young participants under unpressured recognition conditions in the experiments presented here. However, it is not apparent how Minerva2, or any such global strength model, even with a variable decision criterion, can handle the dissociative effects of repetition under conditions of aging or recognition time pressure.

However, theories that posit an additional basis for the recognition decision explain dissociations such as the present ones rather neatly. Although it is true that apparent dissociations can in fact be derived from models that postulate only a single contributing process to the recognition decision (cf. Donaldson, 1996; Ratcliff, Van Zandt, & McKoon, 1995), single-process models cannot easily produce double dissociations of the sort reported here. Evidence of such dissociations is buttressed by the recent finding by McDermott and Watson (in press) that the function relating study time to false memory is nonmonotone. Initially (between 20 and 250 msec) both true and false recognition increase with study time, but at longer intervals (1 to 5 s) true memory increases whereas false memory drops. The nature of the particular augmenting process in recognition is open to debate.

Several suggestions have been made that appear quite satisfactory. These explanations can be generally categorized into theories that posit additional stores of information (*multistorage* hypotheses) and those that posit additional processes (*multioperation* hypotheses). An example of the former is provided by Payne et al. (1996; see also Brainerd, Reyna, & Mojardin, 1999), who have argued that separate representations of *gist* and *verbatim* information (see Reyna & Brainerd, 1995) may account for false-memory phenomena. According to this interpretation, encoding of an event (in this case, a word) entails both the formation of a verbatim representation of the event and an evolving extraction of gist from the entire study set. False alarms to critical foils result from a superthreshold match between the test item and the gist representation, whereas memory for old items presumably reflects both gist and verbatim representations. The slower forgetting of gist information is evident in the dramatic finding that levels of false memory can overtake levels of veridical memory after a delay (McDermott, 1996).

As an example of a multioperation hypothesis, Israel and Schacter (1997; see also Schacter, Israel, & Racine, 1999) proposed that, under conditions that promote the encoding of information that strongly distinguishes study items from one another, the criteria for recognition are shifted to demand more detailed recollection in order to support recognition. Consistent with this interpretation, they found that presenting a picture of the item concurrent with its word label reduced false memory for nonpresented associates. Other examples of such hypotheses include the influential process-dissociation procedure of Jacoby (1991) and other models derived in the vein of Mandler's (1980) distinction between familiarity and recollection, including those of Brainerd et al. (1999); Buchner, Erdfelder, and Vaterrodt-Plunecke (1995); and Yonelinas, Regehr, and Jacoby (1995). The present results suggest that familiarity in recognition is augmented by a mnemonic capacity that allows the recognizer to rely progressively less on familiarity and more on memories rooted in time and place, such as source memory (Benjamin & Craik, in press), recollection (Jacoby, 1999), or verbatim memory (Reyna & Brainerd, 1995).

Knowledge of the study set increases the familiarity of semantically related distractors but, by also increasing source memory (or recollection, or verbatim memory) for the truly studied items, allows participants to set more stringent criteria for endorsing an item based solely on that familiarity. Because the presentation of an unstudied item can never truly be remembered, such items will be endorsed only when they are familiar and levels of recollection are sufficiently low to warrant using familiarity as diagnostic of prior study.

An alternative account of the processes underlying the endorsement of semantically related distractors involves the participants accurately remembering their construal and rehearsal of nonpresented items. By that logic, the acceptance of such items as "old" reflects an accurate memory for the item, but a mistaken source attribution (Johnson & Raye, 1981; Marsh & Bower, 1999). However, the present data indicate that the case is not nearly so clean. Repetition, which increases the opportunity to generate and rehearse the critical item, decreases the probability of falsely endorsing that item for young participants under normal testing conditions.

The false-memory paradigm provides a new and somewhat different vantage point to address the conceptual issues surrounding dual processes in recognition. In particular, the procedure elicits false-alarm rates out of the typical range of truncated variability. Furthermore, it can aid in the generation of dual-process theories that specify multiple bases for the rejection, rather than endorsement, of test items. Consider the following abbreviated description of a revealing finding by Loftus (1997). In that experiment, the author attempted to induce memories from childhood into a group of participants. Some participants were exposed to a false memory about an event during their infancy (exposure to a dangling mobile) and others to an event from kindergarten (having a hanging spiral disk in the classroom). They hypothesized that the participants in the latter condition would be more prone to false memories because of the greater plausibility of remembering an event from kindergarten.

However, their results showed otherwise. Whereas only 25% of the kindergarten group "remembered" the implanted event, 60% of the infancy group reported a memory of their implanted event. Apparently, in the kindergarten case, participants are less willing to endorse an event exactly because they know that they have memories from kindergarten. The infancy group is more willing to attribute the increasing familiarity of the implanted event to actual prior experience because they have no additional memorial basis for rejecting it. It is this type of reasoning that appears to be a critical part of the decision process in recognition; criteria for translating familiarity into a recognition judgment shift with the evaluated diagnosticity of that familiarity.

Two examples in the domain of recognition memory for words illustrate this principle. First, Brown, Lewis, and Monk (1977) demonstrated that certain highly familiar stimuli, such as our own names, elicit very low false-alarm rates. Second, Jacoby and Whitehouse (1989) showed that artificially enhanced familiarity of a to-be-recognized word increases false alarms to that word only if the source of that familiarity (in that case, an immediately prior exposure) is not appreciated. These examples illustrate the necessity of considering not familiarity per se, but rather the violations of expected familiarity as a basis for the phenomenological sense of pastness (Benjamin, Bjork, & Hirshman, 1998; Whittlesea & Williams, 1998).

In the typical false-memory experiment, both studied items and critical foils elicit this violation of expected familiarity at test, as evidenced by the high levels of false recognition of those foils. However, young participants under unspeeded conditions have the ability to use increasing knowledge of the study set to decrease their susceptibility to falsely recognizing the unseen critical foils. Results from signal-detection analysis suggest that they do so by increasing the recognition criterion. This notion is similar to the one proposed by Schacter et al. (1999) that different response modes—essentially different response criteria—are invoked under different circumstances.

However, under time-pressured conditions and in elderly participants, the memorial bases for this criterion shift are compromised, perhaps owing to the greater difficulty older adults have with conscious recollection (Jacoby, 1999) and source memory (Benjamin & Craik, in press; McIntyre & Craik, 1987) and the more time-consuming retrieval of such knowledge (e.g., Benjamin & Bjork, 2000; Hintzman & Curran, 1994). The net effect is that familiarity-based mnemonic sources play a relatively greater role in the recognition decision and foster a positive relationship between knowledge of the study set and the endorsement of distractors plausibly from that set.

To summarize, the effects of repetition on false recognition appear to be dual in nature: Repetition increases the familiarity of semantic associates but also allows for a more restrictive criterion to be imposed on the actual recognition decision. These two effects can be seen in dissociations with aging and response time pressure: Young participants, under unspeeded conditions, exhibit an ability to reject more critical lures associated with multiply than with singly presented categories; older participants and young participants tested under time pressure falsely endorse more critical lures from multiply than from singly presented categories. I have briefly speculated on the implications of such dissociations for the understanding of recognition in humans and reviewed some basic components of a theory that involves a rapid evaluation of familiarity and, under some circumstances, additional assessment as to the source and diagnosticity of that familiarity. The false-memory paradigm allows for a more rigorous examination of the contribution of those processes to mistaken recognition, and can ably serve not only to address applied interests but also to provide a novel stance from which to attack the problems of recognition memory in general.

References

Arndt, J., & Hirshman, E. (1998). True and false recognition in MINERVA2: Explanations from a global matching perspective. *Journal of Memory and Language, 39,* 371–391.

Atkinson, R. C., & Juola, J. F. (1974). Search and decision processes in recognition memory. In D. H. Krantz, R. C. Atkinson, R. D. Luce, & P. Suppes (Eds.), *Contemporary developments in mathematical psychology: Learning, memory, and thinking* (Vol. 1, pp. 243–293). San Francisco: Freeman.

Balota, D. A., Cortese, M. J., Duchek, J. M., Adams, D., Roediger, H. L. III, McDermott, K. B., & Yerys, B. E. (1999). Veridical and false memories in healthy older adults and in dementia of the Alzheimer's type. *Cognitive Neuropsychology, 16,* 361–384.

Benjamin, A. S., & Bjork, R. A. (2000). Dissociating recognition speed and accuracy for words processed via primary versus secondary rehearsal. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26,* 638–648.

Benjamin, A. S., Bjork, R. A., & Hirshman, E. (1998). Predicting the future and reconstructing the past: A Bayesian characterization of the utility of participative fluency. *Acta Psychologica, 98,* 267–290.

Benjamin, A. S., Bjork, R. A., & Schwartz, B. L. (1998). The mismeasure of memory: When retrieval fluency is misleading as a metacognitive index. *Journal of Experimental Psychology: General, 127,* 55–68.

Benjamin, A. S., & Craik, F. I. M. (in press). Parallel effects of aging and time pressure on memory for source: Evidence from the spacing effect. *Memory & Cognition.*

Benjamin, A. S., Kester, J. D., Craik, F. I. M., & Black, S. (in press). Pathological familiarity and false recognition: A case study. *Brain and Cognition.*

Brainerd, C. J., Reyna, V. F., & Mojardin, A. H. (1999). Conjoint recognition. *Psychological Review, 106,* 160–179.

Brown, J., Lewis, V. J., & Monk, A. F. (1977). Memorability, word frequency, and negative recognition. *Quarterly Journal of Experimental Psychology, 29,* 461–473.

Buchner, A., Erdfelder, E., & Vaterrodt-Plunecke, B. (1995). Toward unbiased measurement of conscious and unconscious memory processes. *Journal of Experimental Psychology: General, 124,* 137–160.

Ceci, S. J., & Bruck, M. N. (1995). *Jeopardy in the courtroom: A scientific analysis of children's testimony.* Washington, DC: American Psychological Association.

Clark, S. E., & Gronlund, S. D. (1996). Global matching models of recognition memory: How the models match the data. *Psychonomic Bulletin and Review, 3,* 37–60.

Cohen, G., & Faulkner, D. (1989). Age differences in source forgetting: Effects on reality monitoring and on eyewitness testimony. *Psychology and Aging, 4,* 10–17.

Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology, 58,* 17–22.

Donaldson, W. (1996). The role of decision processes in remembering and knowing. *Memory & Cognition, 24,* 523–533.

Glanzer, M., Adams, J. K., Iverson, G. J., & Kim, K. (1993). The regularities of recognition memory. *Psychological Review, 100,* 546–567.

Hintzman, D. L. (1986). "Schema abstraction" in a multiple-trace memory model. *Psychological Review, 93,* 411–428.

Hintzman, D. L. (1988). Judgments of frequency and recognition memory in a multiple-trace memory model. *Psychological Review, 95,* 528–551.

Hintzman, D. L., & Curran, T. (1994). Retrieval dynamics of recognition and frequency judgments: Evidence for separate processes of familiarity and recall. *Journal of Memory and Language, 33,* 1–18.

Hirshman, E. (1995). Decision processes in recognition memory: Criterion shifts and the list-strength paradigm. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21,* 302–313.

Israel, L., & Schacter, D. L. (1997). Pictorial encoding reduces false recognition of semantic associates. *Psychonomic Bulletin and Review, 4,* 577–581.

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language, 30,* 513–541.

Jacoby, L. L. (1999). Ironic effects of repetition: Measuring age-related differences in memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25,* 3–22.

Jacoby, L. L., Toth, J. P., & Yonelinas, A. P. (1993). Separating conscious and unconscious influences of memory: Measuring recollection. *Journal of Experimental Psychology: General, 122,* 139–154.

Jacoby, L. L., & Whitehouse, K. (1989). An illusion of memory: False recognition influenced by unconscious perception. *Journal of Experimental Psychology: General, 118,* 126–135.

Johnson, M. K. (1991). Reality monitoring: Evidence from confabulation in organic brain disease patients. In G. P. Prigatano & D. L. Schacter (Eds.), *Awareness of deficit after brain injury: Clinical and theoretical issues* (pp. 176–197). New York: Oxford University Press.

Johnson, M. K., & Raye, C. L. (1981). Reality monitoring. *Psychological Review, 88,* 67–85.

Kensinger, E. A., & Schacter, D. L. (1999). When true memories suppress false memories: Effects of aging. *Cognitive Neuropsychology, 16,* 399–415.

Lockhart, R. S., & Murdock, B. B. (1970). Memory and the theory of signal detection. *Psychological Bulletin, 74,* 100–109.

Loftus, E. F. (1979). The malleability of memory. *American Scientist, 67,* 312–320.

Loftus, E. F. (1993). The reality of repressed memories. *American Psychologist, 48,* 518–537.

Loftus, E. F. (1997). Memory for a past that never was. *Current Directions in Psychological Science, 6,* 60–64.

Lynn, S. J., Lock, T. G., Myers, B., & Payne, D. G. (1997). Recalling the unrecallable: Should hypnosis be used to recover memories in psychotherapy? *Current Directions in Psychological Science, 6,* 79–83.

Lynn, S. J., & Nash, M. R. (1994). Truth in memory: Ramifications for psychotherapy and hypnotherapy. *American Journal of Hypnosis, 36,* 194–208.

Mandler, G. (1980). Recognizing: The judgment of previous occurrence. *Psychological Review, 87,* 252–271.

Marsh, E. J., & Bower, G. H. (1999, November). *Misattributing thoughts to perception: The role of source errors in creating false memories.* Paper presented at the 40th Annual Meeting of the Psychonomic Society, Los Angeles.

McDermott, K. B. (1996). The persistence of false memories in list recall. *Journal of Memory and Language, 35,* 212–230.

McDermott, K. B., & Watson, J. (in press). A nonmonotonic relation between presentation duration and false recall: Evidence for multiple factors underlying associatively-induced false memories. *Journal of Memory and Language.*

McIntyre, J. S., & Craik, F. I. M. (1987). Age differences in memory for item and source information. *Canadian Journal of Psychology, 41,* 175–192.

Metcalfe, J., & Wiebe, D. (1987). Intuition in insight and non-insight problem solving. *Memory & Cognition, 15,* 238–246.

Miller, M. B., & Wolford, G. L. (1999). Theoretical commentary: The role of criterion shift in false memory. *Psychological Review, 106,* 398–405.

Mitchell, D. B., Hunt, R. R., & Schmitt, F. A. (1986). The generation effect and reality monitoring: Evidence from dementia and normal aging. *Journal of Gerontology, 41,* 79–84.

Payne, D. G., Elie, C. J., Blackwell, J. M., & Neuschatz, J. S. (1996). Memory illusions: Recalling, recognizing, and recollecting events that never occurred. *Journal of Memory and Language, 35,* 261–285.

Payne, D. G., Neuschatz, J. S., Lampinen, J. M., & Lynn, S. J. (1997). Compelling memory illusions: The qualitative characteristics of false memories. *Current Directions in Psychological Science, 6,* 56–59.

Pezdek, K., & Banks, W. P. (1996). *The recovered memory/false memory debate.* San Diego, CA: Academic Press.

Ratcliff, R., Van Zandt, T., & McKoon, G. (1995). Process dissociation, single process theories, and recognition memory. *Journal of Experimental Psychology: General, 124,* 352–374.

Reyna, V. F., & Brainerd, C. J. (1995). Fuzzy-trace theory: An interim synthesis. *Learning and Individual Differences, 7,* 1–75.

Roediger, H. L. III. (1996). Memory illusions. *Journal of Memory and Language, 35,* 76–100.

Roediger, H. L. III, & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21,* 803–814.

Schacter, D. L., Israel, L., & Racine, C. (1999). Suppressing false recognition in younger and older adults: The distinctiveness heuristic. *Journal of Memory and Language, 40,* 1–24.

Schacter, D. L., Verfaellie, M., & Pradere, D. (1996). The neuropsychology of memory illusions: False recall and recognition in amnesic patients. *Journal of Memory and Language, 35,* 319–334.

Snodgrass, J. G., & Corwin, J. (1988). Pragmatics of measuring recognition memory: Applications to dementia and amnesia. *Journal of Experimental Psychology: General, 117,* 34–50.

Sommers, M. S., & Lewis, B. P. (1999). Who really lives next door? Creating false memories with phonological neighbors. *Journal of Memory and Language, 40,* 83–108.

Whittlesea, B. W. A., & Williams, L. D. (1998). Why do strangers feel familiar, but friends don't? A discrepancy–attribution account of feelings of familiarity. *Acta Psychologica, 98,* 141–166.

Wickens, T. D., & Hirshman, E. (2000). False memories and statistical design theory: Comment on Miller and Wolford (1999) and Roediger and McDermott (1999). *Psychological Review, 107,* 377–383.

Wixted, J. T., & Stretch, V. (2000). The case against a criterion-shift account of false memory. *Psychological Review, 107,* 368–376.

Yonelinas, A. P., Regehr, G., & Jacoby, L. L. (1995). Incorporating response bias in a dual-process theory of memory. *Journal of Memory and Language, 34,* 821–835.

Received February 15, 2000
Revision received July 31, 2000
Accepted August 22, 2000 ■